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DESCRIPTIONS

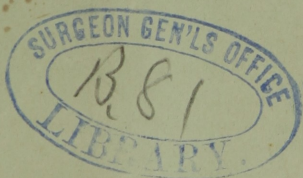
OF

Extinct Batrachia and Reptilia

FROM THE PERMIAN FORMATION OF TEXAS.

By E. D. COPE. ✓

(Read before the American Philosophical Society, April 5th, 1878.)



Descriptions of Extinct Batrachia and Reptilia from the Permian formation of Texas.

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REPTILIA.

DIADECTES SIDEROPELICUS. Gen. et. sp. nov.

Char. Gen. Teeth with short and much compressed crowns, whose long axis is transverse to that of the jaws. Edges of the crowns obtuse, with tuberosities on some of them, distinct from the principal apex. The latter is worn off very obliquely by attrition in all of the specimens. The crowns covered with an enamel-like substance which has no especial sculpture. Alveoli not separated. The external alveolar border in each jaw is more elevated than the internal, and in the superior series at least, diverges from the tooth-line backwards and outwards. The surface of attrition descends outwards in the maxillary series, and rises inwards in the dentary series. A large fossa pierces the inner alveolar border just behind the inner extremity of each tooth.

The affinities of this very singular form cannot yet be determined. The mandibular ramus rises directly from the posterior extremity of the dental series, showing that there is a coronoid elevation of the dentary bone as in *Dinosauria*. The teeth are received into deep alveoli. It is probable that the vertebræ are amphicæalous. The animals belonging to this genus were, in all probability, herbivorous.

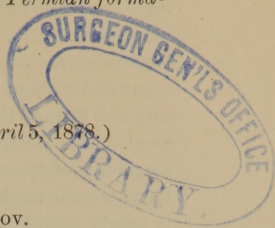
Char. Specif. The jaws, and probably other bones of three individuals of this species, represent it in my collection. The lateral tuberosity of the teeth already described is on the most elevated, hence opposite, borders of the crowns in the two jaws. It differs in its degree of prominence in different teeth, but is subject to attrition in one of the jaws at least. The form of the principal worn surface is an elongate oval. The investing layer of the crown is perfectly smooth, excepting between the lesser and greater cusps, where the obtuse edge is slightly longitudinally grooved. The surface of the jaws is not sculptured.

<i>Measurements.</i>		<i>M.</i>
Greatest elevation of a tooth (No. 1).....		.011
Diameters of crown {	transverse.....	.006
	antero-posterior.....	.012
Four teeth occupy.....		.042
Four alveoli of No. 2, occupy.....		.024

The jaws are as large as those of a medium-sized alligator.

DIADECTES LATIBUCCATUS. Sp. nov.

The anterior portion of a probably maxillary bone represents this species. On comparison with the corresponding portion of the jaw of *D. sidero-*



ropelicus, the following characteristic marks appear: The tooth-line diverges much more strongly inwards from the maxillary border in the *D. latibuccatus*, leaving a wide groove between the two. This groove is separated by a narrow horizontal partition from a corresponding one of the superior face of the same element, and its surface is longitudinally roughened. The teeth are closely placed, and the series turns with the anterior extremity of the jaw, abruptly inwards. The transverse diameter of the teeth lessens to just posterior to the point of curvature, so that their section is nearly round; at and anterior to the curve, the wide transverse diameter is resumed, the last alveolus preserved making an angle of 45° with those in the posterior part of the jaw. The external surface of the maxillary bone is roughened, as is also the case in the *D. sideropelicus*, with coarser and finer irregular impressions, fossæ and grooves.

Measurements.	M.
Width of jaw at ninth tooth from curve.....	.036
Width of ninth tooth from curve.....	.011
“ “ fourth “ “ “ .....	.006
“ “ tooth at curve.....	.008
“ “ third tooth anterior to curve.....	.010
“ “ jaw at curve.....	.019
Elevation of alveolar part of jaw.....	.018
Three teeth in.....	.015

There are other fragments of jaws referable to *Diadectes* whose specific reference is uncertain.

BOLOSARUS STRIATUS. Gen. et. sp. nov.

Char. Gen. Teeth fixed in shallow alveoli, and with the crowns expanded transversely to the axis of the jaws. The crowns swollen at the base, and with low apex, divided vertically into two equal portions. The postero-internal half in the maxillary series is low and horizontal; the antero-external portion forms a curved cusp, which has a semicircular section. The teeth of the lower jaw are similar, but the relative positions of the ledge and cusp are reversed. Anterior teeth of superior series composed of external cusp and internal ledge. No enlarged canine or incisor teeth. Bones of face not sculptured.

This genus is represented by a good many remains, which include some partially complete crania. These show that there is no quadratojugal arch, and that the quadrate is of the flat character of that of the *Anomodontia*, and was probably immovable. The orbit is complete behind, and there is a strong squamosal arch. The vertebræ are amphicoelous, and probably notochordal. The neural arches are freely articulated with the centrum, and the zygapophyses and neural spine are well developed.

The vertebræ resemble those of *Lysorophus** (Cope) from the Illinois Permian, but they do not display the deep longitudinal fossæ of that genus.

* Proceed. Amer. Philos. Soc. 1877, p. 187.

Char. Specif. The external surface of the crown is marked to the apex with waved grooves of the enamel. The edge of the elevated cusp, which presents posteriorly in the maxillary teeth, constitutes the abrupt termination of the exterior face, and is serrate by the interference of the sulci. The edge of the basal ledge is slightly serrate. The muzzle is rather elongate, and the sides of the maxillary and dentary bones are plane and smooth. The mandible is rather narrow, and forms a narrow wedge in profile outline. It rises posteriorly behind the dental line. The teeth are separated by intervals as wide as a tooth.

<i>Measurements.</i>	<i>M.</i>
Long diameter of orbit No. 1.....	.0130
Depth of upper jaw at orbit.....	.0045
“ lower jaw at front of orbit.....	.0050
Four teeth in.....	.0080
Elevation of a crown.....	.0025
Transverse diameter of inferior molar No. 2.....	.0025

From the same locality as the *Diadectes sideropelicus*.

A slight modification of character is found in two imperfect crania. The principal character is to be seen in the teeth. The enamel of the external surface of the cusp is not sulcate, but is smooth; and the posterior cutting edge of the cusp is much less distinct. It is, in fact, obtuse, and not serrate. The orbit is large, and the front and muzzle are regularly decurved to the premaxillary border. The angle of the mandible is moderately prominent, and is massive and obtusely truncate. The interorbital region is flat in the transverse direction.

<i>Measurements.</i>	<i>M.</i>
Length of skuli to mandibular angle.....	.050
“ orbit.....	.015
Long diameter of orbit.....	.018
Width of interorbital region.....	.009
Six teeth in.....	.010

BOLOSABRUS RAPIDENS. Sp. nov.

Established primarily on a tooth from the posterior or middle portion of the series, with which is associated another, probably from an anterior position in the jaw. The size is many times greater than that of the species of this genus already described, and it is uncertain whether the posterior tooth possesses the internal ledge characteristic of them. The anterior tooth does not possess it. The transverse diameter of the crown is considerably greater than the antero-posterior, and the convexity of the outer side is without facets. One side of the curve is flatter than the other. The enamel is perfectly smooth. The inner face is occupied by the surface of attrition of the corresponding tooth of the opposite jaw. The supposed anterior tooth is from another locality. Its section is similar to that of the present tooth, and the enamel is similarly smooth. The cutting edges are both smooth, and bounded by a little groove next the plane inner face. The

crown is much more elevated than that of the tooth first described, and is in general shaped like a claw. It may be from the pterygoid bone of another genus.

	<i>Measurements.</i>	<i>M.</i>
Elevation of crown (axial).....		.010
Diameter of crown {	antero-posterior .....	.006
	transverse.....	.008

PARIOTICHUS BRACHYOPS. Gen. et. sp. nov.

Char. Gen. This form is represented by a cranium which has lost its superficial osseous stratum at some points, and the entire occipital region. The temporal fossæ were covered by a roof continuous with the postorbital region; the zygomatic arch extends low down, producing a resemblance to certain tortoises. The orbits are small and lateral, and the muzzle is short, with terminal nares. Their exact character cannot be ascertained. The teeth are rooted, and have compressed obtuse crowns, with cutting edge; they diminish in length posteriorly, and do not display any elongate canine. The cranial bones do not exhibit any sculpture.

This genus is quite distinct from the others here described from corresponding parts of the skeleton. In the constitution of the skull it resembles Prof. Owen's genus *Kisticephalus* from supposed Triassic beds of South Africa, but differs totally in dentition.

Char. Specif. The interorbital width is twice the diameter of an orbit, and is nearly flat. The cheeks behind the orbits are swollen; the canthus rostralis is obtuse. The muzzle is obtuse, broadly rounded, and somewhat depressed; the nostrils were not large. The orbits are subround, and measure one half of the length of the muzzle measured axially above. The mandibular rami are not deep. The longest teeth are below and in front of the anterior border of the orbit; posterior to this point they diminish rapidly, and are reduced to a very small size. The crowns of the greater number of the teeth are short and much compressed, and the enamel is coarsely longitudinally grooved. An anterior mandibular tooth has a subconic crown.

	<i>Measurements.</i>	<i>M.</i>
Width of skull at parietal region.....		.020
Length " from " .....		.022
Interorbital width.....		.010
Four teeth in.. ..		.004
Length of root and crown of a tooth.....		.002

From the locality of the last species.

ECTOCYNODON ORDINATUS. Gen. et sp. nov.

Char. Gen. Cranium short and wide, with large post-frontal bones and a large orbit. Cranial bones sculptured, but no lyra. Teeth rhizodont, with elongate compressed crowns with anterior and posterior cutting edges. One of these between the orbit and nostril larger and longer than the others, and lying outside of the closed dentary bone. Mandibular

symphysis not sutural, but ligamentous. Terminal mandibular tooth not small. Teeth not faceted, simple.

This genus, which I suppose to be reptilian, is represented by a specimen which lacks the posterior portion of the skull; hence its near affinities cannot be determined. In the character of the cranial sculpture it resembles crocodiles, and the Labyrinthodont genera cotemporary with it, and differs from *Lacertilia* with cranial sculpture known to me.

Char. Specif. Parietal and frontal regions flat, the latter joined to the maxillary by a rectangular canthus. Interorbital region wide, equal to the diameter of the orbit. Sculpture of vertex in longitudinal series of pits of considerable irregularity. There are ten or twelve such rows between the orbits. The crowns of the teeth are obtuse, and their surface smooth.

Measurements.		M.
Interorbital width of skull.....		.009
Width between prefrontal borders.....		.014
Depth of facial plate of maxillary.....		.007
“ ramus mandibuli at orbit.....		.006
“ “ “ near end.....		.003
Length of short maxillary tooth.....		.0015
“ long “ “ .....		.0030
Width “ “ “ .....		.0015

The skull of this species is about as large as that of the *Heloderma suspectum*.

CLEPSYDROPS NATALIS. Sp. nov.

This reptile is represented by numerous portions of the skeleton, including a cranium, and thus offers the best basis of information as to the character of the genus *Clepsydrops* which has yet come into our hands. This furnishes numerous interesting characters, which as found in a single individual furnish a basis of estimation for the entire group.

Char. Gen., et cætera. There is no quadratojugal arch, but the zygomatic and postorbital arches are present. The squamosal extremity of the zygomatic arch descends low on the quadrate as in turtles, preventing mobility of the latter. The quadrate is not prominent in the specimen, and appears to have been a thin bone, as in *Ectocynodon*. The nostril is large and latero-anterior. The symphysis of the mandible is short, and the premaxillary bones appear to be distinct; they are separated in the specimen by displacement, with the indication that the junction was sutural. The teeth were of different sizes, and the premaxillaries and canines are distinguished from the others by their proportions. All are sub-round in section, with more or less defined anterior and posterior cutting edges. The premaxillary teeth are larger anteriorly, diminish posteriorly, and are separated by a notched diastema from the large canine. The succeeding teeth are of medium proportions. The roots are sunk in deep alveoli. There is no surface sculpture of the cranial bones, which is the character distinguishing the genus *Ectocynodon* from *Clepsydrops*.

The vertebræ have been described elsewhere, but important additions to our knowledge can now be made. There are mostly small intercentra throughout the dorsal and caudal series, in the latter prolonged into two processes below, constituting chevron bones. The transverse processes on the dorsal and lumbar vertebræ are undivided, and on some of the dorsals, the ribs articulate with the centrum as well. They are present on the anterior but wanting on the posterior caudal vertebræ. In adults the neural arch is coössified with the centrum, and on the lumbar and sacral region the neural spines are greatly elevated, indicating the presence of a fin like that of *Basiliscus*. In one of the allied species the diapophyses of three vertebræ are vertically expanded for the attachment of the ilium, but the centra are not coössified.

The humerus in this genus is of remarkable character. Its proximal extremity is expanded and regularly convex, with the articular surface at right angles to the sides of the bone, and not developing a head. There is a strong deltoid ridge or tuberosity, not extending far from the head. The shaft is much contracted, and the distal end is more expanded than the proximal. It is flattened, and supports no condyle. Its outline is transverse at the middle and truncate at each lateral extremity. A large supracondylar foramen pierces the basal part of the distal expansion near the inner border. The opposite edge is strongly grooved longitudinally, the groove being bounded in front by a prominent crest, which sinks just proximad of the distal border.

The ilium is a flat bone which contracts downwards and forwards to the pubis. The latter is something like the ilium in form, widening in the opposite direction, *i. e.* downwards and forwards. Its form is something like that of the *Crocodylia*, and it is uncertain whether those of opposite sides unite below. The ischium is a remarkable bone. It is greatly produced anteriorly and posteriorly to the acetabulum, in forming with that of the opposite side, a keeled boat-shaped body, which at its superior middle portion includes the inferior part of the acetabulum. In *C. natalis*, the anterior apex is below the middle line of the pubes near their anterior border. In the same species there is an additional small element between the ilium and pubis on the superior side at their junction. The acetabulum is formed by the interrupted junction of the three elements.

The femur possesses no third trochanter, and the head and great trochanter are not separated by a neck. The little trochanter is large, and the condyles are well defined. The head of the tibia is expanded, and the fibula is well developed at both extremities. The phalanges are moderately elongate, and are depressed. The claws are curved and compressed below.

The various remains of this genus now in my possession, and especially the skeleton of *C. natalis*, show that the determinations of various parts of the skeleton made from isolated fragments from Illinois, were correct.

Of the general affinities of this genus it is only necessary now to state that my reference of it to the *Rhynchocephalia* is confirmed. It differs

from the recent species of the order in the absence of quadrato-jugal arch, and the remarkably developed ischia. On this account I refer to *Clepsydrops* and its allies as a distinct suborder under the name of *Pelycosauria*.

Char. Specif. The muzzle of this species is compressed and descends obtusely at the end as in *Bolosaurus striatus*. The nostril and orbit are quite large. The first premaxillary tooth is the largest and has a silky striation of the enamel; its crown is much less than that of the canine. The canine originates below a point a short distance posterior to the nostril.

<i>Measurements.</i>	<i>M.</i>
Length of skull to posterior base of quadrate.....	0.124
Diameter of nostril.....	.019
Depth of zygoma at orbit.....	.012
Length of crown of canine tooth.....	.016
Antero-posterior diameter of canine tooth.....	.005

The centra of the lumbar vertebræ are compressed, but not deeper than long, nor acute on the median line below. The diapophyses are wide, and descend towards the anterior articular border. The neural spines are compressed, and are very long. Their apices are slender and curved backwards. The faces of the zygapophyses are oblique upwards and outwards. The caudal vertebræ have subround articular extremities anteriorly, and become more compressed posteriorly. The diapophyses are median on the former, and gradually become smaller to extinction. The zygapophyses are strong, and the neural spines continue long for a considerable part of the length of the entire series. The centrum is concave below the diapophyses, and has a median inferior rib.

<i>Measurements.</i>	<i>M.</i>
Length of centrum of fourth from last lumbar vertebræ.	.018
Vertical diameter of " " "	.017
Transverse diameter of " " "	.018
Elevation of neural arch and spine of last lumbar.....	.087
Antero-posterior extent of ilium.....	.059
" " " " pubis.....	.060
" " " " ischium.....	.143
Depth of pelvis.....	.080
Length of femur.....	.120
Long diameter of proximal end.....	.041
Length of tibia.....	.085
Transverse width of tibia.....	.029
Length of eleven caudal vertebræ.....	.172
" " fourth caudal "	.016
" " eleventh caudal "	.014
Transverse diameter of caudal.....	.012

This species differs from the *C. vinslovi* in the more robust caudal vertebræ. It is also considerably larger, agreeing in this respect with the *C. pedunculatus*. In the latter the long transverse processes are decurved

and narrowed at the extremities in a manner not seen in any of the known vertebræ of *C. natalis*.

DIMETRODON INCISIVUS. Gen. et sp. nov.

Char. Gen. Dentition as in *Clepsydrops* in the superior series. Pubic bone not distinct from ischium. Humerus with trochlear condyles and a defined proximal articular surface.

The genus *Dimetrodon* embraces larger forms than the known species of *Clepsydrops*. It is probable that the species had the neural spines in the lumbar and dorsal regions elevated in the same way. The humerus while of the same general character as that of *Clepsydrops*, differs remarkably in its more perfect articular surfaces, indicating a terrestrial habit as distinguished from a probably aquatic one in the former genus. The supracondylar foramen is present in this genus, and the proximal articular surface winds obliquely round the expanded extremity of the bone.

The separate jaws of *D. incisivus* show well the character of the dental insertions. A strong thickening of the inner wall of the maxillary bone is all that represents the palatine lamina. This enlargement does not extend to the level of the external alveolar margin, which thus forms a parapet. The roots of the teeth are long, and are contained in deep alveoli of the palatine thickening; but the portion of them which projects beyond the alveoli is adherent to the external parapet by the side, and hence the teeth appear to be pleurodont. They are shed in after the absorption of the root in consequence of the presence of the crown of the successional tooth. The process commences at the inner alveolar border, and extends inwards and upwards invading the palatine wall of the maxillary bone.

Dimetrodon is allied to *Deuterosaurus* Eichw. and *Eurosaurus* Fisch. as defined by Meyer, the former known from a portion of the cranium, the latter from bones of the skeleton. From the former it differs in the persistence of the sutures separating the elements of the jaws, supposing the figure reproduced by Owen (Quar. Journ. Geol. Society, 1876, p. 358) to be correct in the omission of them. Apart from this, *Deuterosaurus* has much more elevated nostrils, more numerous incisor teeth, and wants the extensive diastema in front of the superior canine. *Lycosaurus* Ow. from the South African Trias resembles it much more nearly, but does not present the greatly enlarged anterior incisor teeth of *Dimetrodon*.

Char. Specif. This saurian is established on the nearly complete premaxillary and maxillary bones of the right side with the left maxillary of the same individual. Associated with these are portions of the post-frontal, frontal and nasal bones of the right side of perhaps the same individual, but as the pieces are loose, this relation cannot be positively affirmed. Portions of the maxillary, premaxillary and other bones, with isolated teeth of numerous other individuals are in my possession.

The first named specimens show that the mutual premaxillary and premaxillo maxillary sutures are distinct. There is a deep emargination of the border of the jaw at the latter suture, and the maxillary alveolar bor-

ders is gently convex downwards. The nostril is large, and is directed forwards as well as outwards: the premaxillary spines are narrow. The form of the muzzle and jaws when in normal relation was vertical and compressed in front. The premaxillary border of the jaw is rounded and contracted behind the nostril; the outline then expands backwards. There are but two incisor teeth, of which the anterior is much larger than the second. Its root is irregular in section owing to the presence of one or more shallow longitudinal grooves. The pulp cavity of some of the larger teeth is much contracted opposite these grooves by the corresponding internal face, which is disproportionately convex. The anterior two teeth of the maxillary bone are larger than those that follow, the anterior exceeding even the first incisor. The other maxillaries are smaller and sub-equal, excepting the last two, which are the smallest. The crowns of the teeth are lenticular in transverse section, the external side being much more convex than the internal. The cutting edges are defined from the convexity of the latter by a shallow groove at the base of each. The edge is not crenate as in *Lalaps* and allied genera, but presents much the same appearance owing to the presence of a transverse corrugation. There are fourteen teeth and empty alveoli in the maxillary bone.

Measurements.

M.

Length of premaxillary axially, to middle of maxillary suture .....	.040
Length of maxillary bone on alveolar edge from middle of premax. suture .....	.230
Greatest width of premaxillary .....	.036
Depth of face of premaxillary bone at nostril .....	.030
Length of diastema (chord) .....	.032
Depth of maxillary at third tooth .....	.110
“ “ antepenultimate tooth .....	.066
Diameter of base of crown of first incisor tooth .....	.015
“ first maxillary tooth .....	.018
“ fourth “ “ .....	.009

The portion of cranium above mentioned displays a number of peculiarities. The orbit is lateral, and has a prominent and convex superciliary border. The zygomatic arch is so curved upwards as to complete the orbit behind by the intervention of a postorbital or postfrontal bone, which separates the malar and squamosal bones from mutual contact. In front of this bone a portion of the frontal forms the superciliary border, and in front of this, the prefrontal sends a wide process behind the lachrymal to the orbit. This bone resembles a nasal bone in form, and extends forwards, and is decurved at the extremity. The width of the descending or malar process of the postfrontal is such as to partially separate the orbit from the zygomatic fossa. The superciliary surface is swollen, and is interrupted by a transverse groove on the orbital part of the prefrontal. There is a vertical open groove on the malar process of the postfrontal.

Several large pelvic bones corresponding with those which I have called

ischia in *Clepsydrops natalis*, are of a size appropriate to the present species. They include both the ilia, ischia and pubes in one mass, forming a compressed boat-shaped body with a prominent inferior keel.

The prominent character which distinguishes this species is the shortness of the ischiatic symphysis. Its extent anterior to the acetabulum is only one-half the diameter of the latter, while it equals that diameter in the *C. gigas*. It follows from this, that the crest arising from the anterior border of the acetabulum is abruptly decurved a little anterior to the latter, and descends to the inferior keel at a very steep angle. At its point of decurvature is a prominent tuberosity. The front of the symphysis pubis presents an obtuse keel, which terminates short of the apex. The inferior border of the acetabulum is not sharply defined, except at its posterior portion.

<i>Measurements.</i>	<i>M.</i>
Total length.....	.260
Length from posterior border of acetabulum forwards..	.148
Long diameter of acetabulum.....	.095
Total vertical diameter to superior border of acetabulum	.135
Length of anterior symphysis.....	.085
From the same locality as the last species.	

DIMETRODON RECTIFORMIS. Sp. nov.

This species is represented by portions of the vertebral columns of three individuals at least. Its size exceeds considerably that of the *Clepsydrops natalis*, equaling that of the *C. (? Embolophorus) limbatus* Cope. Of the latter species I possess numerous vertebræ, and they all differ in a marked manner from the present species.

In *Dimetrodon rectiformis*, the depth of the centra does not exceed the length. The margins of the articular faces are not twisted, and the articular faces of the zygapophyses are horizontal. The opposite is the case in the *C. limbatus*. The spaces for the intercentra are small; they are large in *C. limbatus*. The vertebra described as typical is a posterior dorsal. Here the diapophyses is nearly sessile, and below the line connecting the zygapophyses. Its costal articular surface is narrowed downwards and forwards, almost reaching the recurved border of the anterior face. The neural spine is much elevated, and the sides of the centrum are concave. The inferior articular borders are connected by an acute nearly horizontal edged keel.

	<i>Measurements.</i>	<i>M.</i>
Diameter of centrum	{ antero-posterior.....	.031
	{ transverse.....	.034
	{ vertical.....	.026
Expanse of posterior zygapophyses.....		.030
Length of base of neural spine.....		.025

From the same region as the other species here described.

DIMETRODON GIGAS. Sp. nov.

Clepsydrops gigas. American Naturalist, May, 1878, p. 327.

This animal is only represented in my collection so far by a large part of the pelvis. This is of the same character as that of the *C. natalis*, but differs in several details of form and is three times as large in linear measurements. The portion anterior to the acetabulum is shorter than in the *C. natalis*, and relatively deeper. The raised borders of the acetabulum unite, and form a thick obtuse horizontal crest, which continues to the apex, which consists of a broadly expanded shovel-like projection. This symphyseal portion is quite elongate, and carries on its supero-anterior face an obtuse median keel. The opposed elements diverge above the anterior part of the acetabulum. The latter is shallow but entire; its most prominent borders are the anterior and postero-inferior.

<i>Measurements.</i>	M.
Length from posterior border of acetabulum forwards...	.200
Long diameter of acetabulum .....	.100
Total vertical diameter to superior border of acetabulum	.155
Length of anterior symphysis .....	.175

EPICORDYLUS ERYTHROLITICUS. Gen. et sp. nov.

Char. Gen. *Epicordylus* is known from a large part of the vertebral column, including all the regions excepting the cervical, so far as at present appears. In general the vertebræ resemble those of *Clepsydrops*, having well-developed intercentra. The diapophyses are at the base of the neural arch, and are prominent, and with large undivided articular extremity; they are not present on the caudal vertebræ. The neural spines are compressed below and enlarged transversely above, so as to be claviform. They are not elongated over the lumbar or sacral regions, but are similar to those of the dorsal vertebræ at those points. The *ossa ilii* resemble those of *Clepsydrops*. The zygapophyses are as usual oblique upwards and outwards, and the centra are not shortened.

Char. Specif. The centra are a little compressed, and higher than wide. In the anterior caudal region they are a good deal more compressed. The intercentra in a part of the dorsal series are larger than in any known species of *Clepsydrops*. The neural spines are bilobed at the apex on the sacral region, and become shortly bifurcate on the caudal series.

<i>Measurements.</i>	M.
Length of a series of seventeen dorsal vertebræ.....	.610
“ an anterior neural spine.....	.050
“ posterior.....	.070
“ tubercular costal face of anterior dorsal....	.020
“ “ “ on seventh vertebræ of	
the series from the last.....	.035
“ five caudal vertebræ of probably the same	
animal.....	.180
Elevation of fourth caudal neural spine.....	.057

Width of neural spine at summit.....	.035
Length of ilium.....	.120

This species appears to have been about the size of the Mississippi alligator. Unfortunately the cranium is unknown, but probably some of the jaws and teeth in my possession belong to it.

From the region above already mentioned.

METARMOSARUUS FOSSATUS. Gen. et sp. nov.

Char. Gen. There are numerous vertebræ in the collection, from the median and anterior dorsal parts of the column, which differ from those of *Clepsydrops* and *Epicordylus* in their small antero posterior diameter. That these all belong to one species, or even one genus, is not probable, in view of the many differences which they present. I select one of them whose characters are most strongly marked, and designate it as above, without deciding as yet, how many of the others which agree with it in some respects, may hereafter be associated with it as to species or genus.

The centrum is a good deal shorter than wide, and like those of all the other genera here described, is deeply biconcave. I have not yet ascertained whether it is notochordal, owing to the state of the specimens. The diapophyses project just below the base of the neural arch, and are short and with small tubercular facet. There is no capitular facet. The facet for the intercentrum is excavated at the anterior extremity of the base of the centrum and is quite small. The neural canal is rather large. The anterior zygapophyses have a peculiar form, their articular faces being directed downwards and outwards. This character, together with the form of the centrum and intercentrum, distinguishes this genus at once from those previously described.

Char. Specif. The posterior articular face is a little deeper than wide, and has rather thick recurved margins. The sides are concave, and the middle line below protuberant (in section), but not keeled. The intercentral fossa is a transversely oval pit well defined all round, and not interrupting the contour of the inferior margins of the articular faces.

	Measurements.	M.
Diameter of centrum	{ antero-posterior.....	.021
	{ transverse behind.....	.030
	{ vertical ".....	.030
	{ " in front.....	.024
Width of intercentral fossa.....		.010
Expanse of posterior zygapophyses.....		.025
About the size of the <i>Dimetrodon rectiformis</i> .		

EMPEDOCLES ALATUS. Gen. et sp. nov.

Char. Gen. This genus is of the same type as those already described as allied to *Clepsydrops*. I know of it from numerous vertebræ, but few of which belong to any one individual, four consecutive centra being the largest number I have obtained in association. The various specimens

described, belong to the cervical and dorsal regions, and it is not unlikely that one series which is not yet extricated from the matrix, includes also lumbar, sacral and caudals. But of the latter I am not at present able to give any account.

Both dorsal and cervical vertebræ possess centra of the general character of those of *Clepsydrops*, with small intercentra. The neural arches present important differences. There is on the posterior aspect, below the zygapophyses a well developed hyposphen, and on the anterior face a correspondingly strong hypantrum. The structure is identical with that which I have described as present in the genera *Camarasaurus* and *Amphicelium*, but is rather better developed. It disappears at some posterior point of the dorsal series. The zygapophyses are much elevated and spread apart in *Empedocles*, and are connected together back to back. From this junction the diapophysis depends, forming a vertical septum whose inferior extent is greatest on the cervical, and least on the dorsal vertebræ. It is undivided, and as there is no capitular facet on the centrum, the rib had but a single head. The expansion of the diapophyses with that of the posterior zygapophyses gives to the posterior side of the vertebra a remarkable appearance, and forms an oblique roof above the centrum. The neural spine is not elevated, and is very robust, being in some cases greater in the transverse than the antero-posterior diameter, again approximating remotely *Camarasaurus*. Of the dentition nothing is known, but some jaws with teeth of animals allied to *Clepsydrops* may belong here. Probably other portions of the skeleton are in my possession, but I am unable as yet to correlate them.

Char. Specif. The diapophyses are not long, and their articular surfaces are quite elongate downwards and forwards, especially on the cervical centra. On more posterior dorsals the diapophysis arises exclusively from the neural arch, but maintains its very narrow oblique articular face. On all the vertebræ the centrum is about as long as wide, with regular marginal angles without bevel for intercentrum. The sides are concave, and the inferior median line horizontal, and thickened. The neural spine is short in the dorsals, and with a subquadrate section, with the angles lateral and antero-posterior. The apex is excavated at the extremity. The space between the planes of the opposite zygapophyses is strongly convex. The latter have horizontal faces. In other vertebræ the neural spine is more transverse, and the zygapophyses are separated on the median line by a smaller fossa on the anterior face of the arch, and a larger one on the posterior face.

In a specimen in which the hyposphen has disappeared, it is represented by a ridge connecting the posterior zygapophyses, which is decurved over the neural canal.

Measurements.

M.

No. 1, dorsal vertebra of smaller individual.

Total elevation of vertebra105

Elevation of centrum029

“ “ zygapophyses060

<i>Measurements.</i>		M.
Elevation of base of neural spine.....		.083
Width of apex " " " .....		.025
Vertical extent of extremity of diapophysis.....		.036
Diameter of centrum { antero-posterior .....		.026
{ transverse.....		.027
Width between inferior extremities of tubercular facets of diapophyses.....		.066
Width between extremities of zygapophyses .....		.082
Length " " " .....		.042
No. 2, a larger individual.		
Total elevation .....		.130
Diameter of centrum { antero-posterior.....		.029
{ transverse .....		.043
{ vertical.....		.039
Extent of zygapophyses.....		.102
Elevation of neural spine.....		.026

The portions of the vertebral columns referred to this species cannot be reconciled with those of any of the species of *Epicordylus* or *Clepsydrops*. In both of these, large parts of the dorsal series are known, and even if those genera should possess dorsal vertebræ with hyposphen, which is very improbable, the peculiar forms of the zygapophyses and neural spine will still distinguish them widely.

EMBOLOPHORUS FRITILLUS. Gen. et sp. nov.

This form reposes on some dorsal vertebræ with intercentra and ribs in place, which display some interesting characters. The neural arch is co-össified, and the zygapophyses and diapophyses are well developed; the latter not elongate, and standing on the base of the neural arch. The centra are notochordal. The intercentra are narrowed and transversely extended. The ribs are two-headed; the capitulum is received into a fossa of the posterior border of the intercentrum in advance of the vertebra which supports the diapophysis, to which the tuberculum is attached.

The curious mode of articulation of the ribs I have not observed in the species of the genera heretofore described, unless the forms of some of the intercentra of the *Clepsydrops limbatus* indicate it. If so, that species must be removed to *Embolophorus*.

Char. Specif. Centra with a circular section at all points, and contracted at the middle. No carinæ or grooves. The intercentra project beyond the edges of the centra, giving the column the appearance of supporting annular ridges. Their lateral angles extend upwards nearly to the base of the neural arch. The diapophyses are short and are directed upwards and forwards; their extremities are concave. The zygapophyses are large and their articular faces nearly horizontal. The size of this species is small, little exceeding that of the *Bolosaurus striatus*.

Measurements.		M.
Length of a centrum with an intercentrum attached....		.0056
Length of centrum.....		.0040
Diameter of centrum	{ vertical.....	.0035
	{ horizontal.....	.0035
Expanse of diapophyses.....		.0080
“ heads of rib.....		.0035
Elevation to summit of neural canal.....		.0045

Comparison with the vertebræ which I have found associated with the jaws and teeth of *Bolosaurus striatus* reveals the following differences: The neural arches of the latter are distinct; the intercentra are not present on the vertebræ observed (five in one series and five in another); and the centra are compressed with inferior rib. There are no capitular articular facets in the vertebræ of *Bolosaurus* described.

Theropleura retroversa. Gen. et spec. nov.

Char. Gen. Rhynchocephalian reptiles with free neural arch, and a capitular costal articulation on the centrum; the intercentrum probably, and the hyposphen certainly, wanting.

This genus is similar to *Lysorophus* in its free neural arch, but there is no capitular costal articulation on the known vertebræ of that genus. The small costal face of the diapophyses is distinct from what is seen in *Epicordylus* and *Empedocles*.

Char. Specif. Size medium, or rather larger than that of *Clepsydropis natalis*. A number of small vertebræ may belong to a young individual, but I regard as type a dorsal vertebra of an adult, where the suture of the neural arch is visible but adherent. The species is characterized by the wide posterior expansion of the border of the articular face of the centrum, forming the capitular facet for the rib. It approaches near to the diapophysis, and descends to the basal fourth of the centrum. There is an angular ridge passing backwards from the inferior border of the diapophysis to the border of the articular face. Below this angle and behind the capitular costal face the centrum is deeply concave, the concavities of the opposite sides being separated below on the median line by a narrow obtuse keel. The centrum is as deep and long as wide.

Measurements.		M.
Diameter of centrum	{ antero-posterior.....	.025
	{ vertical.....	.025
	{ transverse.....	.025

The small specimens agree with the large one in the strong, longitudinal angle connecting the diapophysis with the posterior border of the centrum, and in the wide capitular articular surface.

Theropleura uniformis. Sp. nov.

This species is represented by the vertebræ of two individuals, and perhaps of two others of smaller size. The dorsal centra are characterized by

* Proceedings Amer. Philos. Soc., 1877, p. 187.

the absence of lateral and inferior edges, and the narrow reflected portion of the anterior border for the capitular facet. The diapophyses are short, and the tubercular surfaces not much extended. The zygapophysial surfaces are but moderately oblique. The sides of the centrum are gently and uniformly concave, and the inferior middle line is obtuse and not prominent.

The centra of the smaller specimens alluded to, are a little depressed, and may pertain to another part of the column.

	Measurements.	M.
Diameters of centrum	{ antero-posterior .....	.021
	{ transverse .....	.022
	{ vertical .....	.021
Expanse of anterior zygapophyses .....		.019
Width of neural canal .....		.009

TEROPLEURA TRIANGULATA.

The centra of the vertebræ of three and probably four individuals represent this reptile. The superior part of these resembles that of the *T. uniformis* in lacking the angle posterior to the diapophysis seen in the *T. retroversa*, and in the small extent of the capitular rib-facet. The inferior part of the centrum differs in the presence of three longitudinal rib like angles, separated by two latero-inferior shallowly concave faces. The median rib is not very prominent, is obtuse, and concave in profile. The articular faces are relatively rather wider than in the vertebræ described as typical of the two species preceding; but in one vertebra (No. 2) the proportions are nearly the same.

In the second vertebra mentioned the neural arch is entirely preserved. The diapophysis is at its base, and of small size; the vertebra is from not behind the median dorsal region. The neural spine is compressed and elevated, and with narrow, truncate apex. The articular faces of the zygapophyses are nearly horizontal.

	Measurements.	M.
Diameters centrum No. 1	{ antero-posterior .....	.018
	{ transverse .....	.017
	{ vertical .....	.016
Diameters centrum No. 2	{ antero-posterior .....	.023
	{ transverse .....	.024
	{ vertical .....	.026
Expanse of anterior zygapophyses .....		.020
Elevation of neural spine above zygapophyses .....		.052
Diameter of do. at summit	{ fore and aft .....	.016
	{ transverse .....	.007

BATRACHIA.

ERYOPS MEGACEPHALUS Cope. Proceed. Amer. Philos. Soc., 1877, p. 188.

To the characters which I have ascribed to the genus *Eryops* as above cited, I now add the following. A series of a few large teeth much exceed-

ing the maxillaries in size within the latter, perhaps on the palatine bone. No row of smaller teeth within the maxillary series, or on the vomer, as in *Mastodonsaurus* and *Capitosaurus*. The choanæ are large, and extend well forwards.

This species is the most abundant as well as the largest Batrachian of the formation. Some of the crania are .500 Ms. in length.

It may be added that the vertebræ which I described (l. c.) under the head of this species, and which were found with the cranium which represents it, may not really belong to it.

PARIOXYS FERRICOLUS. Gen. et sp. nov.

Char. Genericus. Suborder *Labyrinthodontia*. Head of medium proportions, with orbits near the middle of the length, and lateral external nares. Epiotic bones prominent, bounding a deep auditory notch. Mandibular angle projecting beyond the glenoid cavity. Maxillary and premaxillary teeth not large, conic, subequal; within them a series of rather numerous teeth, of near the same size, probably rising from the palatine bone. No lyra discoverable.

This genus resembles *Rhinosaurus* and *Eryops*, but belongs to the group with prolonged mandibular angle. Among these it differs from *Mastodonsaurus* and its immediate allies in the deep auditory notch and prominent epiotic bones. From *Labyrinthodon* and *Anthracosaurus*, the uniform sizes of its teeth distinguish it; while there is no indication of the facial fontanelle of *Dasyceps*, which is otherwise much like *Parioxys*.

Char. Specif. This salamander is represented by two crania of similar size, to one of which a few vertebræ are attached. I have not yet removed the matrix enclosing the latter, as it is a task requiring much time. The general form of the skull is a triangle with rounded sides and narrowed and obtuse apex. The parietal region is rather elevated and wide, and is bounded laterally by a low, angular ridge which extends anteriorly from the epiotic angle, diminishing in prominence to the orbit. The external border of the epiotic next the auditory notch is acute, and the posterior angle is decurved, as though it formed the rim of a large *membranium tympani*. Between the epiotic cornua the supraoccipital border is concave. The middle of the parietal region is concave.

The orbits are large and have prominent rims, which separate a concave interorbital region, which is less than half as wide as the longest (antero-posterior) diameter of the orbit. The rim is most prominent at the front of the orbit, anterior to which the side of the muzzle is somewhat swollen. There is no canthus rostralis; in its stead there is a concavity behind the nares, with an intervening swelling just behind the latter. These are equally lateral and superior in their presentation. The middle of the muzzle is slightly concave, with a low median longitudinal ridge. If there be any sculpture of the surface of the cranial and mandibular bones, it must be slight; where the thin layer of fine grained matrix which invests it has been removed, it is smooth.

The crowns of the teeth are rather slender; one from the posterior part

of the premaxillary bone does not display any cutting edges nor facets. The grooves of inflection are strong, and extend well towards the apex, but they are not numerous.

<i>Measurements.</i>				M.
Length of skull from muzzle to epiotic angle.....				.100
“ “ “ supraoccipital.....				.090
“ “ “ front of orbits.....				.045
“ “ “ nares (axial).....				.012
Width of skull at extremities of quadrates.....				.083
“ “ “ between epiotic angles.....				.035
“ “ “ orbits.....				.015
“ “ “ at front of orbits.....				.066
“ “ “ between nares.....				.015
Long diameter of orbit.....				.025

From the same locality and horizon as the last species.

CRICOTUS HETEROCLITUS Cope.

Proceed. Academy Philada., 1876, p. 405. American Naturalist, May, 1878 (published April 22d), p. 319.

Specimens of a number of individuals probably referable to the above species, exhibit many of its characters. These are very remarkable, and indicate another type of vertebral column heretofore unknown.

The intercentra are more largely developed than in any other genus, having the form and proportions of the centra in the caudal region, and being but little smaller in other portions of the column. In the prepelvic region, the true centra only bear neural arches, which are articulated, and bear short diapophyses at their base. On the caudal region they share the neural arches with the intercentra, while the latter bear the continuous chevron bones exclusively. The neural spines are well developed, and not prolonged, in both regions. The ribs are robust, and the abdomen is protected beneath by a series of long, narrow and flat scales, which form imbricated chevrons directed forwards at the middle line.

The phalanges are short and wide, with but slightly condyloid articulations. The distal one is very short, and terminates in a narrowed obtuse projection, somewhat like those of man, but shorter.

A cranium which accompanied the portions of the trunk above described, may belong to the same species. It is that of a Labyrinthodont in some degree allied to *Trematosaurus*. Its form is elongate and the orbits are behind the middle. The mandibles do not exhibit prominent angles, and the epiotic angles are not distinguished by a notch from the posterior border of the os-quadratum. The epiotic bones and two supraoccipitals form the posterior boundary of the table of the cranium; anterior to which the usual parietals and pterotics extend to the frontals and post-frontals. Below the latter is the postorbital, which is bounded behind by the squamosal (supra-squamosal, Owen, Palæontology, p. 176). The quadrato-jugal is possibly distinct from the large malar. There is a “lyra” of two grooves,

which are widely separated on the anterior part of the muzzle, and which converge in front of the orbits, which they barely reach. Another groove occupies the inferior margin of the dentary bone. There is a deep auricular fossa beneath the epiotic and posterior part of the pterotic bones. There is but one series of teeth on each maxillary and dentary bone exposed by the present condition of the specimen. The teeth are subequal, gradually increasing in size anteriorly where their long diameters are transverse to the axis of the dentary bone. The surface of the cranial bones is not strongly sculptured. Posteriorly it is rather closely, and anteriorly it is sparsely, punctate. The sculpture of the lower jaw is similar, except that it is smoother posteriorly.

As this species has been already described, further detail is not now given. The present specimens show that the species was founded on a caudal intercentrum, and that the *C. discophorus** was founded on dorsal intercentra. They also show that my original reference of loose phalanges to this genus was correct.

ZATRACHYS SERRATUS. Gen. et sp. nov.

Char. Gen. The existence of this genus is demonstrated by various fragments, the most characteristic of which is a portion of a maxillary bone. This probably belonged to a species of the order *Stegocephali*, but whether to the *Ganocephalons* or *Labyrinthodont* division is uncertain, though the evidence is in favor of the former. The teeth are in a single series, and their bases are ankylosed to the bottom of a shallow groove. The external boundary of this groove is more prominent than the internal, so that the attachment of the teeth is shortly pleurodont. The teeth have conic crowns, and have basal grooves indicating the dentinal inflexions common to this group. The maxillary and other bones are characterized by their strong sculpture, in the former the ridges being developed into prominent tubercles in various places.

Char. Specif. The horizontal expansion of the maxillary bone is a character of this species, so that its plane forms an obtuse angle with that of the long axes of the teeth. It presents no palatal lamina. The teeth are separated by intervals of greater width than the diameter of the base. The border of the bone above the teeth is thickened, and the ridges are developed into numerous tubercles. These project externally so as to form a prominent serrate margin entirely overhanging the external alveolar border. The ridges diverge inwards in a radiating manner. The surface is otherwise irregular from the presence of a deep fossa on the outer side within the inner alveolar border.

<i>Measurements.</i>		<i>M.</i>
Length of fragment.....		.018
Width " " .....		.018
" " " alveolar groove.....		.002
Length of prominences beyond alveolar border.....		.003
Diameter of a tooth basis.....		.001
Three teeth in.....		.005

* Proceed. Amer. Philos. Soc., 1878, p. 186.

TRIMERORHACHIS INSIGNIS. Gen. et sp. nov. Ganocephalorum.

See American Naturalist, May (April 22), 1878, p. 328.

This genus is referred to the *Ganocephala* of Owen, as a Stegocephal Batrachian with vertebral centra represented by separate cortical ossifications, and with the chorda dorsalis persistent in the basioccipital region. The basioccipital bone, although ossified, supports no condyles properly so called, but a cup-like articulation for the first vertebra, like that of fishes, but which is perforate for the chorda dorsalis. It possesses the other characters of the suborder in the presence of zygapophyses and of the quadrato-jugal arch.

Char. Gen. The centrum is represented by three cortical ossifications of the chorda-sheath, a median inferior, and two lateral. The lateral pieces are quite distinct from each other, and are in contact with the neurapophyses above, and the posterior border of the median segment in front. The neural arch joins chiefly the lateral elements, but is in slight contact with the lateral summits of the inferior element. The halves of the neural arch are coössified, and support well developed zygapophyses, but no neural spine. A lateral expansion of the base of the neurapophyses represents the diapophysis, but it is horizontal and thin.

The cranial bones are sculptured with pits and reticulate ridges. The parasphenoid bone is flat. The external nostrils are large and superior, and not anterior. The angle of the mandible is little produced, and the glenoid cavity is transverse and wider at the inner than the external extremity. The inner wall of the mandible descends from the glenoid fossa, including with the horizontal outer wall, a deep internal pterygoid fossa. No coronoid bone or process. Symphysis short.

The teeth exhibit the inflected dentine of this and allied groups. So far as preserved, they are simply conic, but there are none with the apices complete. There are two series on each side of the upper jaw, both of which consist of larger teeth at their anterior portions. The anterior teeth of the inner row beneath the external nares, are much the largest. A thin bilateral bone from some part of the roof of the mouth supports some large teeth, and a row of small ones diverging from them on each side. The mandibular teeth are in one principal series, and become a little larger anteriorly. Near the symphysis there are on each side, within the external row, one or two large teeth. The ribs are short and little curved, and they have flat expanded heads. They are attached to the diapophysial expansion of the neural arch. Such limb bones as are preserved are without condyles, and are of relatively small size.

Trimerorhachis differs from *Archegosaurus* in the ossification of the basicranial elements; in the absence of attached neural spines, and in the regular and definite tripartite ossification of the chorda-sheath. The form of the cranium of *Trimerorhachis* is unknown.

Char. Specif. There are two large tusks at the anterior extremity of the inner superior row of teeth, and two similar ones on the plate-like element above described. The inferior border of the mandible rises gradually posteriorly to below the posterior border of the glenoid cavity, behind

which is a short vertical and compressed angular process, which is rounded in profile. There is a patch of small teeth inside of the posterior extremity of the mandibular series. The mandible closes inside of the posterior part of the quadrato-jugal arch. There is a groove near the inner margin of the inferior face of the mandible; external to this the surface is marked with elongate shallow pits. The sculpture of the external side of the ramus is less pronounced, and the pits are smallest near the angle. The pits of the top of the cranium are coarse and well defined. The fragment of maxillary bone is broken off four teeth behind the tusks, and the neural opening has contracted but little at that point. The sculpture of the anterior portion of the maxillary is coarsely reticulate.

The diapophyses of the centrum are oblique rhomboids in form, the anterior upper side receiving the neural arch. The external surface is concave and smooth. The median element, which I call the intercentrum,* is a crescent with subacute horns, which terminate below the anterior part of the posterior zygapophyses. The inferior surface is slightly angulate, with two low latero-inferior ridges, and sometimes a low median one. The surface between them is delicately reticulately sculptured. The neural arch is oblique and highest behind. The combined neurapophyses rise rather abruptly behind the anterior zygapophyses with an obtuse and convex margin. They then descend in an arc to the extremities of the posterior zygapophyses, diverging downwards and separated by an open groove which was doubtless the basis of attachment of the cartilage which represented the neural spine. External surface of the neurapophyses smooth. The zygapophyses have little lateral expansion, but are well defined and prominent antero-posteriorly. The processes which I have alluded to above as diapophyses, may not be such, as they are simply transverse expansions of the anterior inferior portion of the neurapophyses, whose posterior border articulates with the lateral diapophyses of the centrum.

The basioccipital condyloid fossa† is transversely hexagonal in outline, the superior border being deeply notched by the superior portion of the *fossa chordæ dorsalis*. The articular surface itself is funnel-shaped. The parasphenoid bone advances far posteriorly under the basioccipital. It expands into an acute angle on each side below the proötic, and then contracts, so that its sphenoid region is narrower than its occipital extremity. Its surface is slightly concave.

<i>Measurements.</i>	<i>M.</i>
Depth of maxillary bone at middle of nares.....	.021
Width of palatal surface " " .....	.014
Six maxillary teeth " " .....	.014
Diameter of an anterior maxillary tooth.....	.002
" " tusk of inner row.....	.004
Length of ramus mandibuli to anterior border of inter- nal pterygoid fossa.....	.058
Depth of do. at do.....	.023

* American Naturalist, May, 1878, p.323.

† This term is used as preferable in this case to that of occipital condyle.

<i>Measurements.</i>	<i>M.</i>
Length of ramus mandibuli to posterior border of inter-nal pterygoid fossa.....	.015
Depth of ramus mandibuli at do.....	.016
“ “ “ .110 from angle.....	.016
Six posterior mandibular teeth in.....	.011
Transverse extent of glenoid cavity.....	.012
“ diameter of condyloid fossa of occiput.....	.019
Vertical diameter of do.....	.013
Greatest width of parasphenoid... ..	.034
Thickness of do. at sphenoid portion.....	.0035
Three vertebræ (measured below) in.....	.042
Chord of intercentrum.....	.018
Length of intercentrum below.....	.010
Thickness “ “ .....	.002
Total length of neural arch.....	.017
Elevation of do. above posterior zygapophyses.....	.008
Expanse of anterior zygapophyses.....	.007
Long diameter of lateral diapophysis.....	.012
Short “ “ “ .....	.005
Length of a rib.....	.021
Width of head of do.....	.008

This species was abundant during the Permian period in Texas, judging from the number of individuals included in my collection.

RHACHITOMUS VALENS. Gen. et sp. nov. *Ganocephalorum.*

Char. Gen. These are derived exclusively from vertebræ, which appear to belong to only one species. Four is the largest number which has been found consecutively in any one individual, isolated portions of the vertebræ being more abundant. From these, characters of an interesting genus allied to *Trimerorhachis* may be derived.

Each vertebra consists of two segments,—an intercentrum and a neural arch. The true centrum is wanting in the specimens at my disposal, and the intercentrum supports portions of two adjacent neural arches. With these it shares the intervertebral articular face usually borne by the centrum. Each articular face is thus divided into three portions, one third belonging to each neurapophysis, and one third to the intercentrum. Between these the course of the chorda dorsalis is unobstructed. Neural spine present, coössified. Diapophysis large, with a subvertical tubercular costal face. Zygapophyses well developed.

The absence of centrum and presence of neural spine and articular faces on the neurapophyses, with the well-developed diapophyses, distinguish this genus from *Trimerorhachis*. The large intercentra and articular faces of the neural arch distinguish it from *Archegosaurus*.

Char. Specif. The *Rhachitomus valens* is a much larger species than the *Trimerorhachis insignis*, equaling or exceeding the *Empedocles alatus*. The intercentra are very robust; the posterior face is nearly straight, while the inferior border of the anterior face curves backward to meet the

former at an angle. The inferior face is convex transversely, and slightly concave antero-posteriorly. The tubercular rib facets are oval, and are narrowed downwards and forwards. The side of the neurapophysis describes a curve which rises a little to the superior part of the extremity of the diapophysis. The zygapophysial surfaces are as wide as long, and a little oblique. The neural spine is not very elevated, and is very robust; its section is a longitudinal oval. Its summit is truncated and thickened laterally.

<i>Measurements.</i>		M.
Diameter of intercentrum	transverse.....	.035
	antero-posterior.....	.023
Expanse of diapophyses.....		.073
Length of tubercular surface of do.....		.022
Elevation of neural arch.....		.071
“ “ spine.....		.040
Antero-posterior diameter of summit of do.....		.044

PISCES.

CTENODUS PERIPRION. Sp. nov.

This large species is indicated by a fine palatal tooth of the left side. Its outline approaches that of a right-angled triangle, but the hypotenuse is deeply incised by the interrarial notches. The plate is rather thin, and is moderately concave on the inferior face. The ridges number seven, all of which are directed outwards and forwards. They are separated by strong grooves, and have a perfectly smooth and uniform crest, and become more elevated at the distal extremities. The latter are steeply decurved and serrate, both faces being invested with a polished enamel-like layer. This substance is only visible in an edge view, and covers one-half the depth of the margin, being excavated by the extremities of the radiating grooves. The superior face is flat.

The absence of serration from the radiating ridges of this species is a striking feature, allying it to the genus *Ptyonodus*,* where the teeth are wanting.

<i>Measurements.</i>		M.
Length of dental plate.....		.037
Width “ “.....		.018
Thickness at inner border.....		.005
“ “ external border of penultimate crest.....		.007

From the same locality as the species above described.

CTENODUS PORRECTUS. Sp. nov.

Two teeth of the left palate indicate this species. The tooth is characterized by the small number of its crests (six), of which only one, the very small first, is directed backwards, and the last four are directed forwards. The crests are separated by deep grooves, which terminate in deep emarginations. The anterior crest is produced much beyond the extremity of the penultimate, and the latter as much be-

*Proceed. Amer. Philos. Soc., 1877, p. 192.

yond the fourth. The extremities of the crests extend obliquely to their bases, and support four or five dentiform processes. The dense shining layer extends inwards as far as the bases of the serrate portions. The inner face of the anterior crest is oblique, and the posterior inner border curves outwards to behind the first crest, leaving a shelf-like continuation of the palatal surface of the tooth.

<i>Measurements.</i>		<i>M.</i>
Length of tooth.....		.038
Width at third crest.....		.015
Depth opposite third crest.....		.004

This species must be compared with *C. fossatus* Cope, and *C. serratus* Newb. The latter is a wide tooth with less oblique, and fully serrate crests. The former is a narrow species, but the anterior crests are not nearly so extended; it is deeper, and the inner side is vertical, and without the posterior palatal lamina seen in the two species named.

CTENODUS DIALOPHUS. Sp. nov.

Represented by a single left tooth in excellent preservation. Its characters are very marked. It is of narrow form, and has more numerous crests than any other known American species. They number ten, and there are two or three other rudimental ones at the posterior extremity. They are all more transverse than usual, five being directed forwards, and five slightly backwards. The crests are acute, but the grooves and emarginations are not very deep. The crests are entire, except at the obliquely truncate distal extremities, where there are from two to four dentations. The shining layer does not extend within these. The inner border of the tooth is vertical, excepting posteriorly, where the inner border of the crest-bearing portion turns outwards, leaving a narrow ledge of the palatal face. The latter is concave in cross section.

<i>Measurements.</i>		<i>M.</i>
Length (.004 at one end inferential).....		.033
Width at fifth crest.....		.010
Depth opposite fifth crest.....		.004

It is not necessary to compare this species with any other.

OBSERVATIONS ON THE PELYCOSAURIA.

In addition to the type of humerus described under the head of the genus *Clepsydropus*, several other remarkable forms occur in the collection, which are probably referable to the various genera of *Pelycosauria*. I give the following tabular analysis of them:

- A. No condyle; a supracondylar foramen. No special proximal articular surfaces.
- No. 1. (*Clepsydropus*) Specimens 5.
- AA. Condyles and supracondylar foramen.
- a. The shaft uninterrupted.
- No. 2. Condyles longer; smaller.....Sp. 6.
- No. 3. Condyles wider; largerSp. 4.

aa. The shaft interrupted by a prominent diagonal ridge.

No. 4. Epicondyles and ridges enormous. Sp. 1.

AAA. No supracondylar fossa; condyles as in *AA*.

No. 5. Form more slender. Sp. 3.

No. 6. Form more robust. Sp. 1.

The above humeri represent three, and perhaps four genera, which have been probably already named from crania or vertebræ in the preceding pages. No. 1 has been already identified as belonging to the *Clepsydropus natalis*. Nos. 2 and 3 are generally similar to the type referred by Meyer to the *Eurosaurus* of Fischer, which had been previously described as Mammalian by Kutorga; but the epicondyles are more largely developed. Humerus of form No. 4 is very remarkable, resembling in some degree that of a mole, being exceedingly robust, and having the muscular insertions enormously developed. It doubtless belonged to a fossorial animal, possessing great power in the anterior limbs. If we search for vertebræ presenting features corresponding to such a mode of life, we seize at once on those of the genus *Empedocles*. Here the elevated roof-like character of the zygapophyses and the connecting platform suggest protection against superincumbent weight, while additional strength is obtained by the hyposphen articulation below them. The short wide neural spine is highly appropriate also to subterranean habits. It is also probable that the animals possessing the humeri, from No. 2 to No. 6 inclusive, were all more or less fossorial. Humeri Nos. 5 and 6 have the characters of Nos. 2 and 3, but the supracondylar bridge is wanting, and the internal epicondyle not quite so much expanded.

The division *Pelycosauria* is established primarily on the genera *Clepsydropus* and *Dimetrodon*, but their cranial structure renders it highly probable that *Ectocynodon*, *Pariotichus* and *Bolosaurus* belong to it. It is also probable that the genera *Empedocles*, *Embolophorus* and others determined from vertebræ belong to it, as the latter are frequently accompanied by pelvic bones of the type of that of *Dimetrodon*. All the genera known from teeth and crania, are of carnivorous habit, excepting *Bolosaurus* and *Diadectes*; they may be referred to a single family on this account, which I call the *Clepsydropidæ*. *Bolosaurus* will form the type of another family characterized by the transverse position of the crowns of the teeth, under the name of *Bolosauridæ*. Prof. Owen has named a group of Triassic and Permian reptiles the *Theriodonta*, characterized by the mammal-like differentiation of the incisor and canine teeth. The animals thus referred by Prof. Owen probably enter my suborder of *Pelycosauria*, although the structure of their pelvis remains to be ascertained. If so, they correspond with my *Clepsydropidæ*, since Prof. Owen does not include herbivorous forms in his division. As it is plain that the herbivorous and carnivorous types belong to the same order, and probably suborder, it becomes necessary to subordinate the term *Theriodonta* to that of *Pelycosauria*. To another division of reptiles from the South African Trias typified by the

genus *Pareiasaurus* Ow., he gives a special name, expressive of the deeply impressed surfaces of the centra occupied by the remains of the chorda dorsalis. As this, or the perforate condition, is characteristic of all of the *Pelycosauria*, it is probable that it is present in Prof. Owen's *Therodontia* also. It is also evident that since the dental characters of *Pareiasaurus* do not serve to distinguish it as an order from the genera with distinct canine teeth, this group also must be looked upon as a subdivision, perhaps of family value, of the *Pelycosauria* or other parts of the Rhynchocephalous order.

The Texan genera of this group, so far as yet known, are about equally related to the Ural and South African types. The age of the former deposit is the Permian, which includes, according to Murchison, the Todtliegende and Zechstein of Thuringia. The age of the South African beds is uncertain, but is suspected by some authors to be Triassic, and by Owen to be Palæozoic. In discussing the age of the *Clepsydropis* shales of Illinois, which had been referred to the coal measures by all previous investigators, I left the question open as to whether they should be referred to the Permian or Triassic formations.* The evidence now adduced is sufficient to assign the formation, as represented in Illinois and Texas, to the Permian. Besides the saurian genera above mentioned, the existence of the ichthyic genera *Janassa*, *Ctenodus* and *Diplodus*, in both localities, renders this course necessary.

THESES.

1. The horizon of the *Clepsydropis* shales of Illinois and corresponding beds in Texas is Permian.

2. That this period witnessed an abundant life of land and ichthyic vertebrata, the former consisting of Rhynchocephalian reptiles and Stegocephalous *Batrachia*.

3. That in the land vertebrata of this period, the amphiplatyan, procœlous, and opisthocœlous types of vertebral articulation were unknown, and that the vertebral centra are either deeply amphiœlous or notochordal.

4. That in the case of both the *Rhynchocephalia* and *Stegocephali*, a specialized dentition, and in the former order, a specialized limb structure, were superadded to this imperfect vertebral structure.

5. That in the primitive land *Vertebrata* of the Permian, the place of the vertebral centrum was occupied by two elements, the centrum and intercentrum.

6. That the intercentrum, from a position of primary importance, as in *Rhachitonus* and *Trimerorhachis*, became reduced, and finally mostly obliterated, but that it remains at the present day in the anterior dorsal region of some *Lacertilia*, and as the chevron bones of most reptiles and some mammals.

* Proceedings Academy Philadelphia, 1875, p. 405.

